

## **Executive Summary of Washington State Ferries' Liquefied Natural Gas (LNG) Project**

### **Overview:**

After three and a half years of analysis, evaluation and several detailed studies Washington State Ferries (WSF) will seek the U.S. Coast Guard's approval to use Liquefied Natural Gas (LNG) as propulsion fuel.

WSF believes that LNG provides an opportunity to significantly reduce both fuel costs and pollutant emissions. WSF burns nearly 18 million gallons of fuel each year. Fuel is WSF's fastest growing operating expense. The fuel budget in 2012 was nearly 30% of WSF's operating budget at a cost of \$67.3 million. That's \$51.7 million more than it was 12 years ago. WSF anticipates achieving very substantial savings on fuel over the remaining service life of the six vessels by converting to LNG. It could also significantly reduce propulsion related emissions. Modeling of the emission benefits indicate reductions of 89% in particulate matter (PM), 59% in sulfur dioxide (SO<sub>2</sub>), approximately 61% in nitrous oxides (NO<sub>x</sub>) and 28% in carbon dioxide (CO<sub>2</sub>).

WSF also believes that the timing is right because the use of LNG as a marine fuel for passenger ferries has been proven technically and operationally feasible for over a decade. LNG fueled passenger vessels have been operating in Norway since 2000. Additionally, both British Columbia Ferries and Staten Island Ferries are studying options to retrofit their vessels from diesel to LNG fuel. Also, the Société des traversiers du Québec (intra-provincial ferry services in Quebec) has contracted for the construction of three new LNG ferries.

### **Background:**

WSF proposed conversion of its six Issaquah Class vessels would entail retrofitting LNG fuel tanks on the top decks of the vessels. These vessels would be supplied by deliveries from LNG over-the-road tank trucks. The refueling operations would occur at the following WSF ferry terminals: Southworth, Bremerton, Kingston, Clinton and Anacortes.

In March of 2010, WSF received a report it had commissioned from the Glosten Associates of Seattle, WA. The report, *LNG Use for Washington State Ferries*, had several purposes. First, it provided WSF with an introduction into the use of LNG as a marine transportation fuel, and it specifically outlined the relative advantages and challenges for its use by WSF. Second, the study looked at the feasibility of using LNG fuel for new construction and existing vessels. The study covered issues of fuel storage, safety, the process of fueling, existing regulations, and available technology. Third, the study presented an estimate for equipment costs, operating costs, and potential emissions reductions. The study concluded that although the capital cost of the LNG engines and tanks is high compared to conventional diesel equipment, fuel cost savings of \$195.5 million over the life of the six vessels. The study also found that LNG propulsion engines could achieve important emissions reductions.

In February of 2011, WSF made a decision to explore two options for the use of LNG as fuel. The first option was to examine the feasibility of changing the design of the proposed new 144 Car Ferry (later named the Olympic Class) to LNG propulsion. The second option was to retrofit the existing Issaquah Class ferries with new engines and external fuel tanks. The Issaquah Class ferries were selected for consideration because their engine, hull and stability characteristics were best suited.

In September of 2011, WSF submitted a conceptual design proposal for the potential conversion to LNG for the Issaquah Class vessels to the U.S. Coast Guard for review. The conceptual design included the size and placement of the external LNG fuel tanks, the size and placement of new engines and piping. It also evaluated how the proposed changes would affect the stability of the vessels.

In December of 2011, the U.S. Coast Guard Headquarters in Washington D.C. issued a letter of approval for the conceptual design of the Issaquah Class vessels, which stated that the proposal met the existing international standards for design safety. Currently international standards only dictate the physical configuration of vessels as it relates to the construction of LNG fueled vessels. The standards do not address areas of operation such as fueling, training, communications, or emergency response once the vessels have been constructed.

In January of 2012, the Washington State Joint Transportation Committee (JTC) contracted for a study from the Cedar River Group of Seattle, regarding the use of LNG as a fuel for WSF vessels. The study was titled *Evaluating the Use of Liquefied Natural Gas in Washington State Ferries*. The study focused on the following areas: (1) assessment of WSF's work and studies on LNG use; (2) identification of the full range of issues that must be addressed to successfully implement LNG use; and (3) analysis of the cost, risk, timeline, and related implications of implementing LNG use for a retrofit of existing Issaquah class vessels, as well as incorporating LNG as a fuel into the new 144-car vessel design. The study recommended that the Washington State Legislature consider transitioning from diesel fuel to liquefied natural gas for WSF vessels, provided that such funding decisions were made in the context of an overall strategy that addressed operations, business, and vessel deployment and acquisition.

In March of 2012, the Washington State Legislature appropriated funds for WSF to undertake the safety and security risk assessments and planning processes that would be necessary to gain U.S. Coast Guard approval for the operation of LNG fueled vessels.

In April of 2012, WSF and U.S. Coast Guard Sector Puget Sound agreed to follow the processes outlined in U.S. Code of Federal Regulations Title 33, Part 127, as a template for the development of the risk assessment and operational plans since there is no regulatory framework specifically for the operation of LNG fueled passenger ferries. Normally, Title 33, Part 127 applies to the operators of large scale LNG importation or exportation facilities. One

of the key components of these regulations is the creation of a Waterways Suitability Assessment (WSA). The WSA is an intensive process that analyzes the credible navigational, safety and security risks of transporting LNG. The WSA also documents appropriate risk management strategies and the resources needed to implement those strategies.

In May of 2012, WSF issued a Request for Proposal (RFP) to solicit interest from consultants to assist WSF in development of a WSA and operational planning. Five internationally recognized firms with LNG and maritime risk assessment expertise responded to WSF's RFP. From those five firms Det Norske Veritas (DNV), headquartered in Norway, was selected. DNV is one of the world's leading authorities on LNG fueled passenger ferries, and LNG operations. The WSA portion of the contract consisted of:

- Safety, Navigation and Security Risk Assessments that would document conditions that could result in a release of LNG, be it accidental (e.g., collisions, groundings, equipment failure, etc.) or intentional (e.g., terrorist act, sabotage, etc.). The goal of the safety and security assessments was to discern and understand the risks in terms of threats, vulnerabilities, and consequences, so that appropriate risk management strategies could be developed; and a
- Risk Management Plan based on the findings of the safety and security assessments. The risk management plan would identify the best methods to prevent the identified accidents or attacks from occurring.

The operational planning portion of the contract required the development of a LNG Operations Manual. The manual is not part of the WSA process but it includes written procedures for conducting fueling operations, the manual includes:

- A description of the LNG fueling systems
- A description of the training and competency requirements for employees
- Specific procedures for LNG fueling operations
- A description of security requirements during LNG fueling operations

In January of 2013, WSF and DNV held a project kickoff meeting and conducted risk assessment familiarization tours. This included interviews with key WSF staff, tours of the ferry terminals that could be used as fueling locations (Anacortes, Clinton, Kingston, Bremerton and Southworth) and visits to four of the six Issaquah Class vessels.

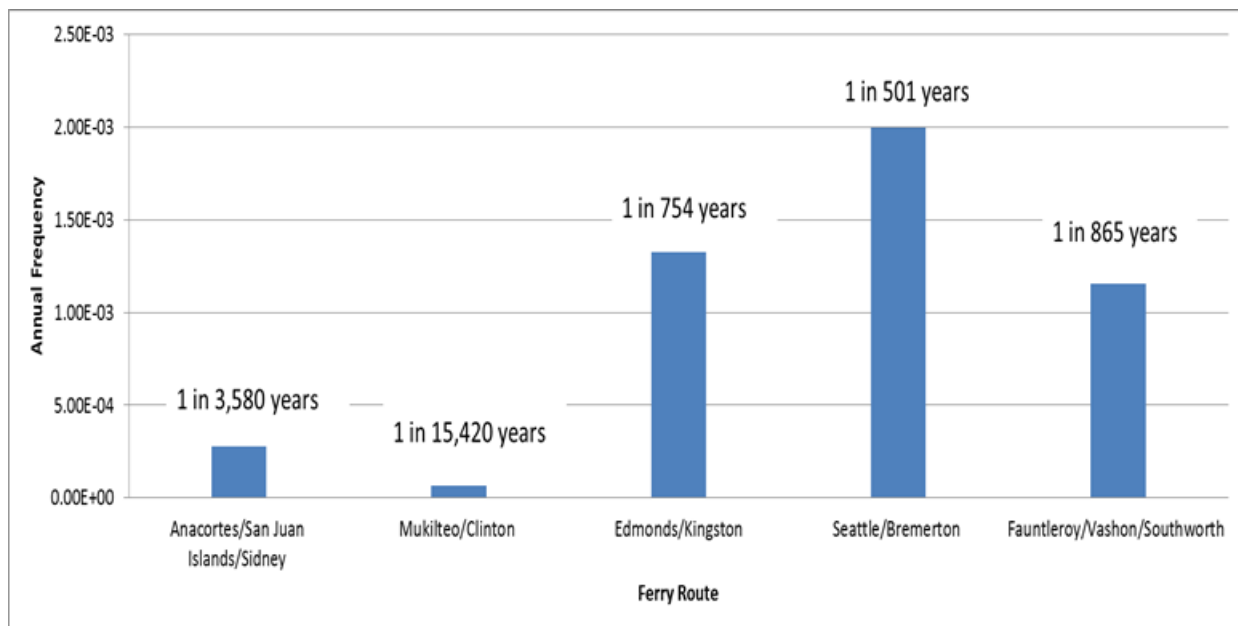
In February of 2013, WSF and DNV hosted three daylong risk assessment workshops relating to navigational, safety and security risks. The participants for these workshops included over 50 individuals representing 13 different local, state, federal, private industry partners, WSF Staff Masters and WSF Staff Chief Engineers, all with navigation, marine operations, environmental, emergency response, and law enforcement expertise. The proceedings from those workshops were documented as part of the WSA.

Between March of 2013 and August of 2013, DNV prepared the WSA which included the Safety, Navigation and Security Risk Assessments, detailed modeling of potential LNG spills, vapor dispersion modeling, and the modeling of collision and damage stability scenarios. DNV also completed and delivered the LNG Operations Manual.

## Synopsis of the WSA Conclusions

### *Navigation Risk*

The WSA found that the placement of the LNG tanks on the top deck of the ferries is an inherently safe design to prevent damage to the LNG tanks in a collision. Because the LNG tanks would be placed 12 m (39 ft.) above the waterline it would take a collision at the precise location, that penetrates the ferry side at least 5 m (16 ft.) deep at a height of 12 m (39 ft.) above the waterline to breach the tanks. Given these three factors DNV concluded that on the route with the highest risk, the probability of such a collision would be a 1 in 500 year event, and for the other routes the risk would be even lower.



**Figure 6-5 Estimated Annual Frequency of a Collision that Could Result in a 5 m (16 ft.)**

**Penetration into a Ferry Side near an LNG Tank (assuming unlimited vertical damage)**

### *Safety Risk*

The WSA evaluated both individual and societal risk. In the absence of existing U.S. risk acceptance criteria DNV used the United Kingdom's criteria as basis of evaluation. Based on

criteria adopted by the United Kingdom Health and Safety Executive (UK HSE), the WSA concluded that the maximum potential individual risk is at the level of  $1 \times 10^{-6}$  (1 in 1,000,000) per year. Another way to phrase this is that if a person stood at the location with the greatest risk, that person's risk of fatality from an LNG release would be 0.000001 per year.

The WSA also addressed societal risk. Societal risk is the risk experienced in a given time period by a whole group of exposed individuals. Societal risks are the relationship between the frequency and the number of people who may be exposed to some level of harm, from the realization of specified hazards, in this case, an accidental LNG release.

The WSA concluded that the estimated societal risk from the operation of a LNG fueled passenger ferry is less than the UK HSE *maximum tolerable criteria*. The risk falls between the maximum tolerable and broadly acceptable risk levels (which is called the ALARP region - As Low as Reasonably Practicable). Based on DNV's previous experience, the societal risk estimated in the WSA is less than many other industrial facilities.

#### *Security Risk*

The security assessment identified eight threat scenarios. These threat scenarios and the recommended risk mitigation measures to address these threats are included as separate appendix to the WSA. This portion of the WSA has been designated as Sensitive Security Information and is only releasable by the U.S. Coast Guard.

#### **Next Steps:**

WSF is submitting a formal Letter of Intent (LOI) to the U.S. Coast Guard. Like the WSA the LOI is part of the regulatory process for an operator intending to build a new large scale LNG storage terminal. The LOI contains basic information about the operator, location and type of proposed project. Submission of the LOI is WSF's declaration of its intent to convert the six ferries to the use of LNG. The submission of the LOI will include the WSA and the LNG Operations Manual for the U.S. Coast Guard's review. The submission of the LOI and WSA marks the official starting point of the U.S. Coast Guard's review process.

**The Future:** WSF believes that given the methodical and comprehensive approach we have taken, we have exceeded current industry standards regarding risk assessment and risk mitigation. We are hopeful that this approach will allow WSF to attain the U.S. Coast Guard's approval. Once the U.S. Coast Guard's approval has been received WSF will seek legislative approval and funding to go forward with the LNG conversions. In the best case scenario, from the time legislative funding is approved to the actual conversion of the first Issaquah Class vessel it would be 2016. The conversions will be phased to coincide with the vessel's scheduled dry-dock examinations. The phased approach is beneficial as it will allow WSF time to refine



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our training, procedures and policies as each vessel is converted. The phased approach will also allow WSF to maintain its current schedule commitments.

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